

REMARKS

This Application has been carefully reviewed in light of the Office Action dated February 24, 2004. Claims 1 to 23 are now pending in the application, with Claims 20 to 23 having been added. Claims 1, 8, 18 and 19 are the independent claims herein. Reconsideration and further examination are respectfully requested.

Applicant thanks the Examiner for his indication of allowable subject matter in Claims 10 to 12. Those claims, however, have not been written in independent form, as suggested by the Examiner, since it is believed that the claims from which they depend are in condition for allowance, as explained below.

Claims 1 to 5 and 17 were rejected under 35 U.S.C. § 103(a) over U.S. Patent 5,220,441 (Gerstenberger), Claims 6 and 7 were rejected under § 103(a) over Gerstenberger in view of U.S. Patent 5,867,591 (Onda), Claims 8, 13 to 17, and 19 were rejected under § 103(a) over Gerstenberger in view of Onda and further in view of U.S. Patent 5,917,962 (Chen), and Claim 9 was rejected under § 103(a) over Gerstenberger in view of Onda and Chen and further in view of U.S. Patent 4,745,562 (Prazdny).

Reconsideration and withdrawal of the rejections are respectfully requested.

The present invention concerns matching points in left and right images of a scene, where the images have at least some overlap area. According to one feature of the invention, a first correspondence search is run on the right image to find a first matching point in the left image. A second correspondence search is then run using the first matching point found by the first correspondence search to find a second matching point in the right image. In running the second correspondence search, the search is not run on any points to the left of the first point in the right image, and its range is narrower than that of the first correspondence search. A match point comprising the first and second matching

points is then selected. As a result, the invention reduces occlusion errors from object boundaries and out-of-focus objects, thus improving the accuracy of stereo matching processes over those processes found in the art.

With specific reference to claims, Claim 1 is a method for locating matching points in two original images of a scene, a left image and a right image, such that the images have at least some overlap area, the method comprising selecting a first point within the overlap area in the right image, running a first correspondence search using the first point to find a first matching point in the left image, running a second correspondence search using the first matching point found by the first correspondence search to find a second matching point in the right image, wherein the second correspondence search is not run on any points to the left of the first point in the right image, and wherein a range of the second correspondence search is narrower than a range of the first correspondence search, and selecting a match point comprising the first matching point and second matching point.

Claim 8 includes features similar to those in Claim 1 as well as additional features. More specifically, Claim 8 is a method for locating matching points in two original images of a scene, a left image and a right image, such that the images have at least some overlap area, the method comprising splitting the left image and the right image into left subimages and right subimages, respectively, wherein each subimage comprises the values of only one of the color coordinates used to define the image with which it is associated, pairing each left subimage with the right subimage which uses the same color coordinate values, running a first correspondence search using a first point in the right subimage to find a first matching point in the left subimage, running a second correspondence search on the first matching point found by the first correspondence search to find a second matching point in the right subimage, wherein the second correspondence

search is not run on any points to the left of the first point in the right subimage and wherein a range of the second correspondence search is narrower than a range of the first correspondence search, selecting match points using the first matching point and the second matching point, and storing each selected match point in a list of match points.

Claim 18 is a system substantially corresponding to Claim 1, and Claim 19 is a computer-readable medium claim substantially corresponding to Claim 8.

The applied art, alone or in any permissible combination, is not seen to disclose or suggest the features of Claims 1, 8, 18, and 19. In particular, the applied art is not seen to disclose or to suggest at least the feature of running a first correspondence search using a first point in a right image to find a first matching point in a left image, and running a second correspondence search using the first matching point found by the first correspondence search to find a second matching point in the right image, wherein the second correspondence search is not run on any points to the left of the first point in the right image, and wherein a range of the second correspondence search is narrower than a range of the first correspondence search.

Gerstenberger is merely seen to disclose a mechanism for determining parallax between a first image array 21 and a second image array 22 of a stereo image pair. The first image array 21 is subdivided into a sub-array of starting points 25 (col. 7, lines 1-5) and a like sub-array of tentative “tie” points 26 are distributed over the pixels of the second image array 22. (col. 7, lines 11-16) An identified tie point 26' is then found in the second image array 22 through a search and correlate process, and the parallax of this point is measured from the tentative tie point 26. (col. 9, lines 23-27, 33-35) With these parallax measurements as starting points, the parallax between the remaining pixels of the two image arrays are calculated through search and correlate operations in image array 22,

which find matching points for pixels in image array 21. (col. 2, lines 59-64; col. 10, lines 23-54; col. 12, 40-62; col. 13, lines 47-56)

Thus, it can readily be seen that the foregoing process in Gerstenberger involves running searches in the second image array 22 for points matching those in the first image array 21. In contrast, the present invention involves a reciprocal search where, after running a first correspondence search to find a first matching point in a *left* image, a second correspondence search is run using the first matching point found by the first correspondence search to find a second matching point in the *right* image. Accordingly, Gerstenberger is not seen to disclose or to suggest at least the feature of running a first correspondence search using a first point in a right image to find a first matching point in a left image, and running a second correspondence search using the first matching point found by the first correspondence search to find a second matching point in the right image, wherein the second correspondence search is not run on any points to the left of the first point in the right image, and wherein a range of the second correspondence search is narrower than a range of the first correspondence search.

The Office Action asserts that “Gerstenberger discloses a method that selects a first point within the overlap area in the right image (point 25 in image 21, Fig. 4). Also, running a first correspondence search using the first point to find a first matching point in the left image (point 26 in image 22, Fig. 4).” Thus, as Applicant understands the position taken in the Office Action, image array 21 of Gerstenberger allegedly corresponds to the right image of the present invention, and image array 22 allegedly corresponds to the left image of the present invention. However, the Office Action then states that “Gerstenberger discloses a method running a second correspondence search on the first matching point (*point 25 in image 21*, Fig. 4) to find a second matching point in the *right*

image ...." (pp. 3-4, emphasis added) Thus, this assertion in the Office Action appears to take the position that Gerstenberger would teach the method of the present invention if image array 21 were the left image. However, this assertion clearly contradicts the Office Action's earlier designation of image array 21 as the right image. Alternatively, if the Office Action's image designations were taken at face value, then the Office Action asserts that Gerstenberger allegedly discloses running the second correspondence search on the first matching point in the *right* image to find a second matching point in the *right* image. In either case, the Office Action is at odds with the present invention's reciprocal search of running a first correspondence search using a first point in a right image to find a first matching point in a left image, and running a second correspondence search using the first matching point found by the first correspondence search to find a second matching point in the right image, wherein the second correspondence search is not run on any points to the left of the first point in the right image, and wherein a range of the second correspondence search is narrower than a range of the first correspondence search.

Onda, Chen and Prazdny have been studied but are not seen to add anything that, when combined with Gerstenberger, would have resulted in the present invention. In this regard, Onda is merely seen to disclose inputting left and right images separately, extracting a feature from each image, and then matching the extracted feature of each image to determine disparity between the images. However, like Gerstenberger, Onda is not seen to disclose or to suggest at least the feature of running a first correspondence search using a first point in a right image to find a first matching point in a left image, running a second correspondence search using the first matching point found by the first correspondence search to find a second matching point in the right image, wherein the second correspondence search is not run on any points to the left of the first point in the

right image, and wherein a range of the second correspondence search is narrower than a range of the first correspondence search.

Chen is merely seen to disclose a process to divide an image into subimages. However, like Gerstenberger and Onda, Chen is not seen to disclose or to suggest at least the feature of running a first correspondence search using a first point in a right image to find a first matching point in a left image, running a second correspondence search using the first matching point found by the first correspondence search to find a second matching point in the right image, wherein the second correspondence search is not run on any points to the left of the first point in the right image, and wherein a range of the second correspondence search is narrower than a range of the first correspondence search.

Prazdny is merely seen to disclose determining disparities between waveform signals using a plurality of matching windows. However, like Gerstenberger, Onda and Chen, Prazdny is not seen to disclose or to suggest at least the feature of running a first correspondence search using a first point in a right image to find a first matching point in a left image, running a second correspondence search using the first matching point found by the first correspondence search to find a second matching point in the right image, wherein the second correspondence search is not run on any points to the left of the first point in the right image, and wherein a range of the second correspondence search is narrower than a range of the first correspondence search.

In view of the foregoing deficiencies of the applied art, independent Claims 1, 8, 18, and 19, as well as the dependent claims therefrom, are believed to be in condition for allowance.

No other matters having been raised, the entire application is believed to be in condition for allowance and such action is respectfully requested at the Examiner's earliest convenience.

Applicant's undersigned attorney may be reached in our Costa Mesa, California office at (714) 540-8700. All correspondence should continue to be directed to our below-listed address.

Respectfully submitted,



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